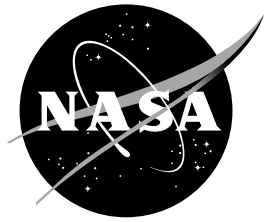


NASA Facts

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The TIMED Mission: Exploring One of the Atmosphere's Last Frontiers

NASA's Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED) mission will study a mysterious region in our atmosphere called the Mesosphere, Lower Thermosphere/Ionosphere, or MLTI.

Located about 40–110 miles (60–180 kilometers) above the Earth, the MLTI is at the edge of space where air pressure is a thousand to a trillion times less than at sea level. Atoms here have their electrons ripped away by X-rays and ultraviolet (UV) light from the Sun, creating an electrified gas used by ham radio operators as a mirror to bounce their transmissions around the world. Electric currents surge through this region, serving as home to that blue-green fire in the sky known as the aurora.

This region also contains white veils of noctilucent clouds, so thin and so high they can only be seen from the ground at twilight when the Earth's shadow blocks sunlight from the lower atmosphere. Once considered to be calm and unchanging, ripples in these noctilucent clouds along with other measurements indicate that this region is actually very turbulent and highly variable. This new data has recently stimulated scientific interest in the MLTI. Today, many scientists believe that such fluctuations may serve as early warning signs of global climate change.

Until TIMED, the MLTI was one of the last frontiers for atmospheric exploration because this region is too high for airplanes or balloons to explore, and too low for direct measurement by satellites. Although the air here is very thin, satellites travelling at orbital speeds still encounter enough particles to burn up. Ground observations can only study a small area located above the observatory, and sub-orbital rockets sent to investigate this region can only study a limited area before they fall to Earth after a few minutes.

TIMED will circumvent these problems by orbiting above the MLTI. The spacecraft's remote sensing instruments will work together with a network of ground-based observation sites gathering an unprecedented set of comprehensive global measurements of the MLTI region.

During its two-year mission, TIMED will study the basic structure of the MLTI region, its chemistry and the flow of energy to and from this layer of the atmosphere. Scientists will analyze how the MLTI affects, and is changed by, the lower atmosphere, how it influences the space near Earth occupied by low-Earth orbiting satellites, and how events on the Sun affect the MLTI.

Why TIMED?

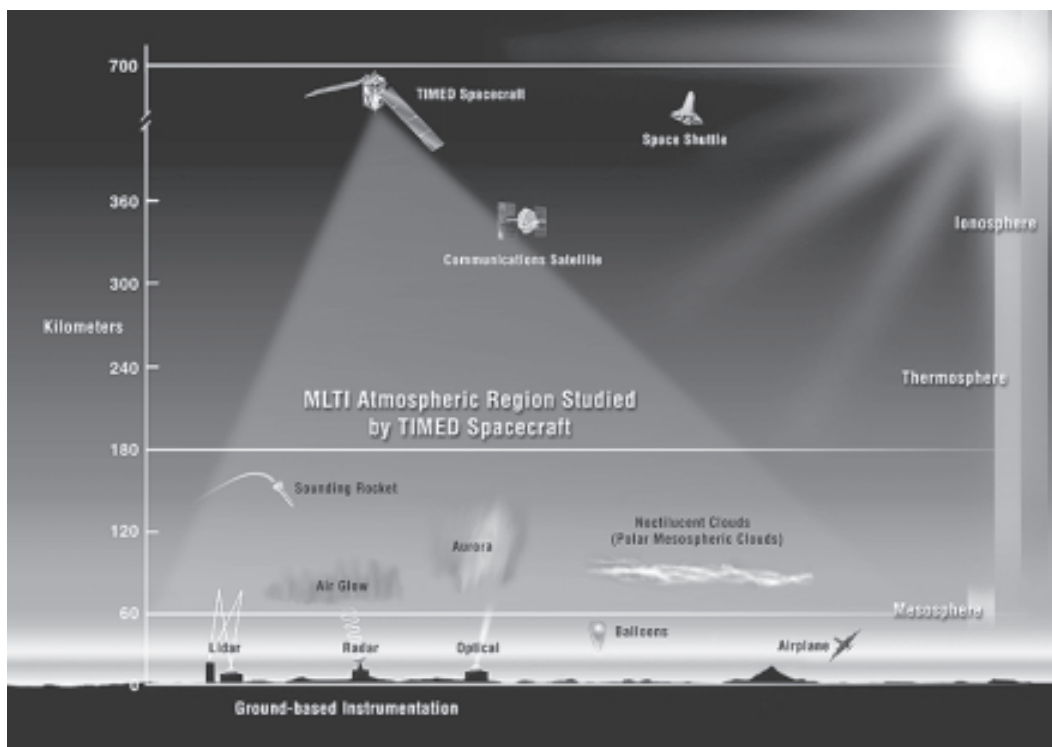
The TIMED mission is vital to researchers for several reasons. Intense solar activity dumps energy into the MLTI, causing it to expand and reach further out into space. As a result, low-Earth orbiting satellites encounter more MLTI particles, which increases their drag and reduces their orbital velocity. Without a reboost, this drag shortens the spacecraft's lifetime by causing it to decay as it re-enters the Earth's atmosphere. Geomagnetic storms and solar activity also can heat the atmosphere considerably at these altitudes, increasing drag on orbiting satellites. After a major magnetic storm in 1989, ground-based controllers had to relocate hundreds of satellites in space and record their new orbits. NASA's Solar Maximum spacecraft was destroyed when this storm knocked it to a lower orbit, causing it to burn up during its reentry.

The MLTI region also is a gateway between Earth's environment and space

where the Sun's energy is first deposited into the Earth's environment. TIMED will focus on understanding the processes behind how energy and energetic particles from the Sun change the chemistry, dynamics and electrical properties of the upper atmosphere. With TIMED, scientists will be able to develop better predictive models of space weather's effects on communications, satellite tracking, spacecraft lifetimes, degradation of spacecraft materials, and on spacecraft reentering the Earth's atmosphere.

The TIMED Spacecraft and Its Instruments

The TIMED spacecraft weighs in at 1,294 pounds (587 kilograms). In its stowed configuration for launch, TIMED measures 8.9 feet (2.72 meters) high by 5.29 feet (1.61 meters) wide. On orbit and after solar array deployment, the spacecraft grows to 38.5 feet (11.73 meters) wide.



Artist concept of the TIMED spacecraft 388 miles (625 kilometers) above the Earth collecting data about the MLTI region. (Illustration courtesy of JHU/APL)

TIMED's science payload consists of four instruments -

- The **Global Ultraviolet Imager (GUVI)** is a collaborative effort between The Johns Hopkins University Applied Physics Laboratory (APL) and The Aerospace Corp. of El Segundo, Calif. GUVI observes the glow of the MLTI region in UV light, providing scientists with its chemical composition and temperature range. It also measures the energy input by solar UV light and the aurora. Although invisible to the human eye, UV light is detectable using special instruments like GUVI. The spectrograph in GUVI breaks UV light into its component "colors," much like a prism separates white light into a rainbow. When the MLTI is energized by solar UV light or the aurora atoms and molecules that comprise the MLTI glow in specific UV colors, allowing scientists to determine its composition and temperature.

The principal investigator for GUVI is Andrew Christensen of The Aerospace Corp. The payload operations center (POC) is located at APL in Laurel, Md.

- The **Solar Extreme Ultraviolet Experiment (SEE)**, built by the University of Colorado, Boulder, observes solar UV irradiance, the primary energy deposited into the MLTI region. SEE determines how much this energy varies and how it affects the atmosphere and changes its composition, and will establish an index of solar variability so scientists can understand the solar UV changes in the MLTI even after the mission ends.

The principal investigator for SEE is Thomas Woods of the University of Colorado, Boulder, where the POC also is located.

- The **TIMED Doppler Interferometer (TIDI)**, built by the University of Michigan, Ann Arbor, measures winds and tempera-

ture of the MLTI region. It determines wind speed and direction by examining tiny changes in the color of light emitted from chemical constituents in the atmosphere. Similar to how the change in pitch from a passing ambulance's siren helps to determine its speed, particles blown by the wind have the color of their emitted light changed slightly, allowing scientists to determine their speed and direction.

The principal investigator for TIDI is Timothy Killeen of the National Center for Atmospheric Research in Boulder, Colo. The POC is located at the University of Michigan, Ann Arbor.

- The **Sounding of the Atmosphere using Broadband Emission Radiometry (SABER)** is a multichannel infrared radiometer that measures a wide range of infrared light emitted by the atmosphere at different altitudes. SABER explores the MLTI to determine its energy balance, atmospheric structure, chemistry and dynamics between atmospheric regions. SABER is a collaborative effort between Hampton University (Va.), which leads the science team; NASA Langley Research Center, which has overall project management and mission implementation responsibility; Utah State University (Logan), which built the instrument; and GATS, Inc. (Newport News, Va), which developed the software and manages the data.

The principal investigator for SABER is James Russell III of Hampton University. The POC for SABER is located at NASA Langley Research Center.

Launch Details

The TIMED spacecraft is scheduled to launch aboard a Boeing Delta II rocket from the Western Test Range at Vandenberg Air Force Base, Calif. TIMED will be inserted into a

388-mile (625-kilometer) circular orbit around the Earth, inclined at 74.1 degrees from the equator.

TIMED is being launch along with Jason-1, an oceanography mission managed jointly by NASA's Jet Propulsion Laboratory in Calif. and the French Space Agency CNES (Centre National d'Etudes Spatiales).

Mission Operations

An innovative operations approach is being used for the TIMED mission. The four TIMED principal investigators have direct control over their instruments and experiments from the individual Payload Operations Centers. This innovative approach was possible in part due to the spacecraft's autonomous design, which helps avoid potential conflicts between the principal investigators' requirements and other on-going spacecraft operations. TIMED carries out many functions on its own, including determining its position, orientation and orbit, reacting accordingly. This unique design allows the spacecraft and its instruments to be controlled from separate locations during the mission.

Mission Themes and Costs

TIMED is NASA's initial mission under its Solar Terrestrial Probes Program, part of the Agency's initiative to lower mission costs and provide more frequent access to space to systematically study the Sun-Earth system. Falling under NASA's Sun-Earth Connection (SEC) theme, which seeks to trace the flow of energy and matter from the Sun and determine its effects on the solar system and our planet, TIMED will provide a comprehensive study of the MLTI from which future studies of changes within this region can be compared and analyzed.

Estimated cost for the spacecraft, instruments and launch vehicle is \$193 million. An additional \$42 million is set aside for data analysis, ground operations, and mission operations costs.

NASA Mission Management

TIMED is sponsored by the Office of Space Science in Washington, DC, and managed by NASA's Goddard Space Flight Center in Greenbelt, Md.

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APL Mission Management

The Johns Hopkins University Applied Physics Laboratory in Laurel, Md., designed, constructed, integrated, tested and will operate the TIMED spacecraft for NASA.

TIMED Project Manager Dave Grant

TIMED Project Scientist

Jeng-Hwa (Sam) Yee

Internet Information

For further details about the TIMED spacecraft and its science mission, visit these web sites:

<http://stp.gsfc.nasa.gov/missions/timed/timed.htm>

<http://www.timed.jhuapl.edu>